

COMMONWEALTH OF PENNSYLVANIA.

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BULLETIN No. 4.

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DEPARTMENT OF FISHERIES.

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# FROG FARMING,

BY

W. E. MEEHAN,  
*Commissioner of Fisheries.*

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# FROG FARMING,

BY

W. E. MEEHAN.

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Frog farming is destined sooner or later to become a very important National Industry. I predict that within a very few years few farmers will neglect to utilize their waste swampy land for the rearing of frogs for the market. Already the United States uses more frogs in six months, it is claimed, than France does in a year. It is safe to say that of those consumed in the markets of the United States ninety per cent. are wild frogs. The demand far exceeds the supply and it is likely to be so for many years to come. The value of the annual catch in the United States is fully \$200,000 and the gross value to the hunters is more than \$50,000. There is not the slightest doubt in the world that were frogs available, the value of the annual catch would leap at once to more than \$1,000,000.

There are some difficulties in the way of a successful farm, but I fully believe there are none which cannot be removed as a result of continued effort and experiment. If effort and experiment in the endeavor to rear frogs successfully were costly, there would be reason for the average farmer to pause before entering on the work; but the work may be carried on with scarcely any money expense. In the first place the land which can be utilized is practically worthless for any other purpose. A swampy area containing springs or a small rill of water or into which a small quantity of water may be introduced will meet every requirement. After the cost of digging the necessary ponds and the cost of fencing them, the outlay is nearly nominal.

The chief difficulty to be overcome in order to successfully rear frogs for the market is to provide an abundant supply of food for the frogs from the time they have developed from tadpoles to the time they are fit to be killed and sold. During that period frogs will eat live food only. The rearing of tadpoles, if certain simple rules are not departed from, is child's play. The caring of young frogs from the period of development to the following spring is not difficult. The unsolved problem is to successfully care for a large number after they are one year old. While the problem is not solved, I

believe that, as a result of instructions and experiments conducted in the fish hatcheries of the State, and the experience of people in other parts of the country who have attempted rudimentary frog culture, I can indicate the solution and the way to success.

## AMERICAN FROGS.

The frog is a cold blooded vertebrate belonging to a class known as a Batrachia, they belong to an order midway between fishes and reptiles, among the latter of which are included not merely snakes but terrapin and alligators. There are more than 250 species known, most of which belong to Africa and the East Indies. There are thirteen edible species in the United States, with rather more than half a dozen sub species or varieties. There are four species common in Pennsylvania.

The generic name of the frog is *Rana*, a Latin word which means frog. The species in Pennsylvania are, *Rana catesbiana* or common bull frog; *Rana virescens*, the spring or leopard frog; *Rana clamata*, the green frog; and *Rana palustris* or the pickerel frog sometimes called the marsh or tiger frog. The first three have white delicate and deliciously flavored meat. The pickerel or marsh frog while not poisonous as often supposed is not esteemed for food purposes, owing to the disagreeable odor of the frog itself, although the odor is not perceptible when the flesh is cooked.

Of the three species highly prized the largest and perhaps the best for general market purposes is the *Rana catesbiana* or the common bull frog. It is the largest of all the species in North America. It reaches a length sometimes of over nine inches and a weight of more than a pound and a half. The body is thick and chunky looking, the head is broad and the skin is slightly rough, the hind toes are fully webbed and the tympanum is much larger than the eye though not as large as the tympanum of the green or spring frog. The back is colored a peculiar dark olivaceous brown or ferruginous plentifully mottled with darker blotches about half the size of the eye. Occasionally the common bull frog is a yellowish green destitute of blotches or yellow markings on the back. The exposed part of the hind legs are heavily blotched with black, the inner side are white with obscure motlings of brown and the throat is often bright yellow. The belly is white. Until recently it was generally accepted as a fact that this species and the green frog passed the first winter in the tadpole stage. But, this from investigation conducted at the State hatcheries, has been shown not to be so. The tadpole of both species will, when the eggs have been deposited, mature nearly as rapidly, as the leopard frog and will be fully developed by autumn. There is very strong evidence, but not fully confirmed, that both the common frog and the

green will spawn twice and that it is the second spawning which remains over until spring in the tadpole stage before developing.

The common bull frog is possessed of solitary habits, hence, while on account of its great size and weight, each specimen would realize a greater amount for the market, it will probably be found impossible to hold as many successfully in a pond of a certain size as would be possible in the case of some other species.

The most delicious and perhaps the best frog for rearing would be the *Rana clamata*, better known as the green or spring frog. While not as large as the common bull frog, it nevertheless grows to a large size. It is massive both as to body and limbs. The posterior part of the back is dark olive shading into a brilliant green at the anterior. The buttocks are mottled with brown and yellowish white and sometimes are almost entirely black. The throat is citron yellow. While it is somewhat solitary in its habits, and in a wild state found only in small companies or in pairs, they can be congregated artificially in large numbers. It is especially aquatic in its habits rarely hunting food on land. The green frog is the first species heard in the spring of the year and while the individual noise is not loud, the aggregate sound from thousands of throats is almost deafening.

The commonest frog in Pennsylvania is *Rana virescens*, variously known as the leopard or shad frog and it is quite small as compared with the common bull frog or green frog, rarely reaching a length of four inches, exclusive of legs. It is readily distinguished from the other two species mentioned, by numerous irregular black, dark brown or olive blotches which mark the creatures from head to foot. The general color is usually bright green and the belly is whitish and a light yellow and unspotted. If a fish culturist desires to rear vast quantities regardless of size and quickly, the leopard frog is the one to cultivate. It is very gregarious in its habits. It will hunt freely on land and reaches a full size much more quickly than the common or green frog. On the other hand, it must be remembered that it will take five or six leopard frogs to make the weight of one green or common frog, and it is generally by weight that frogs are sold.

### HABITS OF FROGS.

The frog hibernates. As soon as frost appears in the fall, the frog seeks the mud in the bottom of ponds and in water which usually it too deep to be frozen solid. If through any cause the water does become frozen to the bottom and the mud is likewise frozen to any degree, the frogs will all be killed. The creatures remain apparently without food throughout the entire winter. With the first advent of spring, before even the grass is green or the leaves show, the frogs



begin issuing from their oozy bed and to gather along the shores and among the grasses and to fill the air both day and night with shrill or deep cries.

With some species the noise is entirely a song of love. The cry of the male calling for his mate and the answering sympathetic chorus of the female. It is during the mating period that frogs are most gregarious. At such times even a common bull frog and the green frog will gather in vast numbers, and it is not until after the eggs have been deposited that they separate into pairs or small groups.

The eggs of the frog are fertilized in much the same manner as those of the fish, that is to say, they are impregnated as they issue from the oviducts of the female.

As each egg passes down the oviduct it receives a thin coating of albuminous material, which immediately after passing from the female becomes a globule. The globules adhere to each other until there is formed a mass resembling a ball or a jelly fish somewhat corrugated. Within a very short time after the eggs enter the water, the albuminous material surrounding them swells until the entire gelatinous mass from one female is from two to three times her size.

The diameter of the egg varies according to the species, but the average is about seven one hundredths of an inch. Development is very rapid under favorable circumstances, and it begins almost from the moment the eggs are fertilized. According to the Manual of Fish Culture, published by the United States Bureau of Fisheries, at first the upper part of the egg is black and the lower white, but the entire egg speedily becomes entirely dark. From spherical the egg soon becomes void. Investigations made by the Department of Fisheries of Pennsylvania bear out this description. The tadpole issues from the egg in from five to thirty days according to the temperature of the water. Naturally the colder the water the longer the time required for hatching. When the tadpole is first hatched both the mouth and the anus are closed and the first food which is composed wholly of the albuminous or gelatinous envelope, is taken into the creature by absorption. By the time this food is all absorbed the mouth and anus are developed, the alimentary canal is lengthened and the tadpole voraciously devours almost anything which comes its way, both animal and vegetable. The tadpole is especially fond of dead animal matter.

Tadpoles from eggs deposited in the spring develop into frogs in from two to three months, depending on the temperature of the water. In exceedingly cold water or where no resting place can be found for the tadpoles on the surface, spring tadpoles may remain undeveloped for an indefinite period, sometimes more than two years.

Tadpoles have attached to them external gills by which respiration is carried on. Later, as development proceeds, the gills are replaced by certain covered external structures. After the lapse of between two and three months, if water conditions continues to be favorable, the hind legs begin to protrude and are shortly fully developed. A week or two later the forelegs, previously concealed by gill membranes, break forth. Up to this time, as I have stated, the tadpole will eat almost nothing, vegetable or animal. But immediately after the appearance of the legs it takes little or no external food, living entirely on the material of its tail. At this time also the gills are replaced by lungs and the creatures begin to clamber to the shore. From this time forth the frog eschews all dead things and lives exclusively on living creatures.

The frog is a cannibal. It is a cannibal even when a tadpole. A citizen of Michigan who attempted frog culture for 25 years in one pond gave it up finally because, as he said, big pollywogs ate small pollywogs. Small frogs ate big and little pollywogs. Large frogs ate small frogs and big and little pollywogs, so that by the time winter set in only a few of the large frogs were alive. It will therefore be essential for a farmer who intends to raise frogs to have separate ponds for the different stages of frog life for the tadpoles, for the young frogs, for the yearlings and market frogs.

## PONDS AND THEIR LOCATION.

As far as my investigations have gone, I should say that a person who proposes to go into frog culture on a really paying scale must devote at least three acres thereto. This area might be covered by about 10 ponds, although it is not necessary that they should be all built at one time. The building of the 10 ponds may be scattered over a period of two years. At the outset there must be built one small pond say about 60 by 20 in which to hatch the frog eggs and care for the tadpoles until they have developed into frogs. While the tadpoles are developing it will be necessary to build at least three more ponds about the same size in which to place the crop of young frogs. Between the time of their completion and the following spring there must be built one, preferably two, ponds of about half an acre in extent, and one or both must be completed before May 1st. At that time it will be necessary that the young frogs be separated into smaller groups.

The same year two or more ponds should be built of about half an acre each to accommodate the frogs the following spring when they are two years old, and a little later two more of the same size to accommodate the three year olds or market frogs.

As I have before stated, frog ponds may be in any waste, marshy land, providing water can be flowed through them or any land whatever into which water can be introduced from a stream or spring, preferably the former, because of a usually higher temperature.

### TADPOLE OR HATCHING POND.

The hatching pond need not be very deep, neither is it essential that it should be exactly 60 by 20 feet. It may be any size desired, but a pond 60 by 20 will safely hatch and develop 60,000 tadpoles, possibly 75,000. A hatching pond need only be from one foot to two and a half feet deep and the deepest portion should be at the middle and outlet end. It should shallow towards each side and the upper end shore where it might not be more than two or three inches deep. It is immaterial what the character of the bottom of the tadpole pond is providing it is not all stony. It is best that it be not very muddy, because if it becomes necessary to net the tadpoles an excessively muddy bottom will be found inconvenient. Not only will the mud be badly stirred up by the net, but the tadpoles will bury themselves therein and many escape capture.

An inflow of an inch pipe of water will be ample. There should at all times be an inflow. In other words, the pond ought never become actually stagnant. First, because it is not best for the development of the tadpoles, second, because stagnant water is the favorite breeding place of the water beetle, one of the worst enemies which the tadpoles have.

### PONDS FOR YOUNG FROGS.

Ponds for frogs freshly developed may be about the same size built for the tadpoles. Just how many can be accommodated in one of that size is not yet determined, but it is certain that 30,000 would be the utmost limit, and it is questionable whether such a pond would hold that number. I feel 10,000 would be safer. A series of small ponds about the size named would theoretically, at least, be preferable, rather than one or two of larger size because of the food question which at this stage becomes important. Hence the number of ponds and the size of the ponds for newly developed frogs must be entirely a matter of experiment and experience.

A pond for young frogs must average not less than two and a half feet in depth, excepting near the side and upper end shores where for a few feet it may be much shallower. At the lower end the depth must be from five to six feet in order to avoid every possibility of the water freezing to the bottom in the severest winter. The entire bottom must be of soft mud from six inches to a foot in depth, to give ample room for the frogs during the hibernating period.



## PONDS FOR TWO AND THREE YEAR OLDS.

Ponds of large size, that is to say, from a little over a quarter to about half an acre each, are absolutely essential for the successful rearing of mature frogs, because arrangements have to be made to provide means by which the frogs may secure natural food. I do not think it advisable to have ponds much larger than half an acre, because they would be, in my estimation, too difficult to handle. This, however, is purely speculation. It might be found by actual experience that a pond covering an acre in extent would be no more difficult to handle than one-half an acre. The general depths of the pond for two and three year olds might be the same as for yearlings. For two and three year olds a supply of water from a two or three inch pipe ought to be sufficient.

## FENCING.

All ponds whether for tadpoles, newly developed frogs or two or three year olds, must be surrounded by a fence. Furthermore, the fence must be set back from the edge of the pond a distance of three or more feet. The fence need not be more than three feet high but it must be either of solid boards or of mosquito wire netting. The latter is by far the cheapest and if painted spring and fall and taken indoors during the winter months will last for two or three seasons. It is immaterial whether the fence be of boards or of wire but there must be at the top a board fastened thereto flat and extending upward. Frogs are nomadic creatures and think a neighbor's pond much better than the one in which they live or are confined. Frogs become especially restless just before a storm. On such an occasion thousands of them attempt to clamber the sides of the fence and make their escape. Many succeed in reaching the top and the flat board is to prevent their getting farther. Fortunately a frog is not like a fly, it cannot creep along a ceiling. Hence, when the board is reached they drop back again into the pond.

If a wire fence be built there must also be a board one foot high extending all along the bottom of the fence and the wire netting must be tacked to the inside. The board should also be buried in the ground to a depth of about six inches. This is necessary for two reasons, first to prevent frogs from burrowing out and second to keep snakes or mice from getting in. The banks of the ponds and the ground extending to the fence on the inside should be allowed to be over-grown with grass or plants which flower, this is for the purpose of attracting insect life and also to afford hiding places for the frogs. The grass, however, must be cut once or twice during the season in order to be certain that snakes have not succeeded in gain-

ing entrance and in order that the frogs in the pond may not be altogether lost to sight.

Ponds built for rearing yearlings, two year olds and three year olds must be plentifully supplied with water lilies. This form of aquatic plants, especially during the blossoming period is a great attractor of insects. The leaves also afford resting places for the frogs and refuge places from enemies. It is true that water lilies will prove more embarrassing to the farmer when he desires to catch frogs but this is an inconvenience which he will have to put up with. We have learned enough to know that water lilies are essential features of successful frog farming.

### FOOD.

During the tadpole stage the question of food is easily solved. Tadpoles will eagerly devour any dead animal matter, but their choice is fish. The quantity of food which they will devour is almost incredible but it is possible to give them too much. About twenty-five pounds of fish a week is sufficient for the needs of 60,000 tadpoles or 15 to 20 pounds of liver will be enough for the same number. If liver be used great care must be exercised that it is entirely fresh for putrid liver or putrid meat of any kind is likely to breed disease among the tadpoles and kill them. Hence, if liver be used it is necessary to feed often and in smaller quantities than if fish be given. In supplying the latter it is only necessary to throw into the water one or more whole fish and the tadpoles will do the rest. In a short time they will leave nothing but the skeleton.

As soon as the hind legs of the tadpoles begin to appear, the quantity of food furnished must be lessened and when all the tadpoles have apparently acquired legs then feeding must be stopped, because as I stated in the beginning of this article, the creatures live only on the material in their tails.

When the tadpoles have fully developed into frogs the latter will take live food only. It is not likely that a sufficient quantity of insect life would come into the pond area to supply the needs of many young frogs without something special being placed there to attract them. This may be done by several means, little mounds of horse manure may be placed around the edge of the pond. Small boards smeared with molasses or honey may also be set about among the grass. If these accessories to the grass and water lilies be found not sufficient it will be necessary to reduce the number of frogs in the pond. It is difficult to determine the proper amount of food because frogs are not regular feeders. They may pursue insects for a day at a time without any appreciable rest and then for a day or two they may not attempt to catch anything to eat unless insects or

other life get fairly in their way when they are captured more as a matter of form than hunger.

When the frogs reach an age of two years or even one year they may be fed with small tadpoles, this can be done by placing a supply in the ponds. They will also eat young minnows but their favorite food is insects. Three year old frogs may be fed with both young frogs and tadpoles. The policy of such food however is doubtful since it tends to encourage cannibalism.

### ENEMIES.

A man engaging in frog farming will soon find that frogs have numerous enemies. They not only possess all which harass fish but have a few others in addition, kingfishers, herons, cranes, owls and crows are among many birds which are fond of both tadpoles and frogs. Snakes, eels and fish seem to regard both the developed and undeveloped frog as tidbits, but probably the most dangerous enemy is the larvæ of the water beetle. It is comparatively easy to guard against the depredations of birds, snakes and even fish but the larvæ of the water beetle is another proposition. The water beetle prefers a pool that is stagnant or still or in which the temperature is high, in which to lay its eggs. The ova hatches in a few days and shortly after, the larvæ is from 2 to 4 inches long. It superficially resembles a helgrammite, its head is like a beetle and possesses two sharp hooked hollow mandibles, the ducts leading into the body. The creature hangs in the water head down and its tail projects just above the water's edge. It seizes a passing tadpole in its sharp manible, and in an instant the blood and internal organs of the victim are sucked through the holes and into the body of the larvæ. As water beetles deposit their eggs by the thousands it is easy to be seen that in a very short time a pond will be filled with these undesirable creatures. They will destroy thousands of tadpoles in twenty-four hours. Three or four days will be sufficient for them to clear out a pond of 60,000 tadpoles. There are but two ways to get rid of these pests, one by from the very beginning to keep a sharp watch for the mature bugs and remove them, or failing that, the instant the larvæ appear to go over the pond four or five times a day with a scap or other net. A good safe thing to do for the larvæ captured is to put them in a kettle of boiling water or furnace.

### CARE OF TADPOLES AND FROGS.

It is essential in frog farming that the ponds be not overcrowded and that is true from the very outset of the work. It will be supposed that it makes very little difference how many eggs were hatched in a pond 60 by 20 feet, provided the tadpoles are removed



soon after they have begun to feed. There could be no greater error. It is true that one could place 1,000,000 tadpoles in a pond of that size and they would live and apparently thrive until the period when the hind legs begin to develop and then within twenty-four or forty-eight hours at most the entire stock would have been found to have died and disappeared. The critical period is when the hind legs are developing. At that time the tadpole requires all its strength and vitality and after the fashion of larvæ the whole life of the tadpole and its feeding is a leading up to and preparing for that critical stage. If there be not enough water room, the tadpoles will be stunted or only half their proper size when the developing period arrives. Consequently, they are lowered in vitality and resultant death. Frequently, through overcrowding, a bacteria is developed which kills them. It is important, therefore, that only the number of eggs should be placed in a pond which will match the number of tadpoles which may safely be carried in the same body of water until after the development period.

### ALGAE.

One of the annoyances to which the frog culturist will find himself subjected to, especially in pure water, will be the rapid growth of the algae. Unless eliminated it will completely fill a pond and destroy everything in it by the mere process of smothering. It is comparatively easy to destroy this pest and it may be done by a solution of copper sulphate. For removing algae in a pond, it may safely be used in the proportions of one part of copper sulphate to 1,000,000 of water; it would possibly do no harm if it were 1 to 500,000. I cannot state this positively, however, for we have used it only in the first named proportions, the same as we would use for destroying algae in a pond containing fish. The proportions may be guessed as to wit: as much as will go on the point of a knife blade to an ordinary barrel of water. After the solution is mixed set the barrel at the head of the pond and syphon the mixture into the pond. Do this three times a week, the algae will almost certainly disappear and without harm to the frogs and tadpoles.

### GATHERING EGGS AND PLANTING THEM.

To start frog farming a bountiful supply of eggs can be secured by visiting any nearby marsh or swampy place containing pools and a little later any pond which contains frogs in any numbers. Spawn can also be found in any stagnant pool by the roadside where frogs are plentiful. Twenty quarts or at most 30 quarts of the spawn will furnish at least 60,000 tadpoles. At the same time also, the mature frogs may be caught and put in a separate pond to be retained as



breeders and it is most likely that from these frogs a second crop of eggs will be secured in July from which may be reared tadpoles which will develop the following spring.

The farmer cannot be impressed too strongly that where eggs are deposited in his ponds by mature frogs, the eggs must be removed at once to a pond containing nothing else than water. If allowed to remain in the pond with the frogs the latter will devour both spawn and young tadpoles. If the eggs are placed in ponds occupied by tadpoles the eggs will be eaten by them, consequently, the only safe place is an empty pond. There is no care, or special spot or special thing to do in placing spawn in a pond excepting that it should be flowed into the water from the egg cans or egg pails and not dropped from a height. The best method is to quietly put the eggs into a net and then lower the latter to the water and gradually sift the bundles of spawn therefrom and allow them to settle as they will on the bottom. In gathering eggs the proper utensils and implements are a twenty quart milk can with a hole in the lid about the size of a quarter, a 10 quart tin pail and a short handled scap net perhaps a foot deep. Before gathering any eggs wet the pail and place therein about an inch of water, then fill with eggs. Carry to the milk can which should previously have been about half full of water. Pour the eggs in and put on the lid. Eggs cared for in this manner, if not too far advanced in incubation when gathered, will carry without any attention from 2 to 14 hours.

It will be seen by the foregoing that frog culture is largely in an experimental stage; that advice as to the size of the ponds and the care of frogs after they have fully developed from tadpoles is given with reserve. The deductions are all from experiments which have been made in the State Fish Hatcheries for the last five or six years. But in that period many changes in pond construction and care of young frogs have been found necessary but the consensus of opinion of the Superintendents of the hatcheries and myself based on these changes are that ponds built after the fashion described are the nearest to what are needed. That the suggestions as to the care of the creatures are the best which can be given under the circumstances from the studies which have been made to the present time. The Department is earnestly desirous that frog culture shall be a success in Pennsylvania and it will welcome any experiences and a report of the results of the work which may be done.



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